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METHOD AND APPARATUS TO TERMINATE DIAL-UP CONNECTIONS ON MOBILE DEVICES

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TECHNICAL FIELD:

This invention relates generally to wireless connectivity between a mobile device or mobile station and a network using Internet Protocol (IP) messaging and, more specifically, relates to establishing an IP connection between a mobile station and a computing device.

BACKGROUND:

In wireless networks, IP connectivity is provided to a mobile station (MS) by the use of at least two modes of operation. The first mode of operation can be referred to as a Browser or Internal Mode, where a connection is initiated from the MS. In this mode, and by example, a browser or mini-browser that runs in the MS can initiate a TCP/IP connection to access the Internet. In a second mode of operation, also referred to as a Relay Mode, the MS is used as a dial-up wireless modem to provide IP connectivity to a computing device, such as a desktop or laptop computer.

In the Internal Mode those applications resident on the MS, such as the mini-browser, communicate with the Internet over-the-air, while in the Relay Mode the IP traffic from the computing device is transparently relayed by the MS to a bearer (e.g., a code division, multiple access (CDMA) or a global system for mobile communication (GSM)/general packet radio system (GPRS) radio bearer).

However, no standard technique is known to currently exist by which the computing device can establish an IP connection with applications residing on the MS, for example with a PIM (Personal Information Management) application, without using a cellular network. As can be appreciated, in some applications it may be less than desirable to use the cellular network for making an IP connection between a MS and a local computing device, such as a laptop computer in one's home or office.

Thus, while standards, procedures and protocols are currently in place for enabling an application that resides on the MS to connect to an application that resides on a computing device over the cellular network, such as a CDMA or GPRS network in the Internal Mode of operation, no standard technique of communication over a short-haul interface, such as a USB, or a Serial IR (short range infrared) or a Bluetooth™ (low power, short range RF) interface, is currently available.

While one might attempt to circumvent this problem by writing special device drivers that would plug-in as, for example, USB, Serial IR, or Bluetooth™ IP interfaces into the computing device's Operating System (OS), this approach would require developing, supporting, installing and possibly uninstalling device drivers for several different computing device architectures.

Prior to this invention, there was no satisfactory solution to the problem that arises when a computing device desires to communicate with an application resident on a MS using IP-based protocols over a medium other than the cellular network.

SUMMARY OF THE PREFERRED EMBODIMENTS

The foregoing and other problems are overcome, and other advantages are realized, in accordance with the presently preferred embodiments of these teachings.

An aspect of this invention concerns making a direct IP connection between a computing device and a MS using IP-based protocols, without involving a cellular network. Another aspect of this invention concerns terminating an IP connection on the MS, rather than using the MS simply as a connection medium, such as a wireless modem. A further aspect of this invention involves making communication possible between peer-to-peer (P2P) applications on the MS and a computing device, without requiring installation of new device drivers or software on the computing device.

In one aspect this invention provides a method to provide an IP connection between a MS and a CD, and includes initiating the set up of the IP connection with a command sent from the CD to the MS over a local interface and, in response to receiving over the

local interface an IP message at the MS from the CD, routing the received IP message to an application that is resident in the MS.

In another aspect this invention provides a computer program stored in a computer readable medium within a MS to provide an IP connection between the MS and a CD. The computer program includes first computer program code that is responsive to a receipt of a command from the CD over a local interface to initiate the set up of the IP connection; and further includes second computer program code that is responsive to receiving over the local interface an IP message from the CD, to route the received IP message to an application that is resident in the MS.

A MS that includes means for implementing the method and the computer program is also disclosed.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other aspects of these teachings are made more evident in the following Detailed Description of the Preferred Embodiments, when read in conjunction with the attached Drawing Figures, wherein:

Fig. 1 illustrates a protocol stack and applications on a MS and a Computing Device (CD);

Fig. 2 illustrates message flow during a CD-initiated connection; and

Fig. 3 illustrates message flow during a MS-initiated connection.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 shows a Protocol Stack and Applications on a MS 10 and a CD 12. The MS 10 may be, as examples, a cellular telephone, or a personal data assistant (PDA), or a personal organizer, or a handheld computing device, or it may contain a combination of two or more of these functions. The CD 12 could be a laptop or a desktop computer, a

handheld computer, or any device having computing capabilities. The MS 10 and CD 12 are assumed to each include a local data processor coupled to a memory that stores at least one peer application 10A, 12A; a protocol stack 10B, 12B containing TCP, UDP IP and Point-to-Point Protocol (PPP) protocols; at least one of an IR/USB and/or Bluetooth™ interface and drivers 10C, 12C connected through a wired or a wireless local interface 13; and in the MS 10 a modem software module 10D, while in the CD 12 a modem and dialer software module 12D. The connections between the protocol stacks 10B, 12B are assumed to be logical connections that are actually made via, in accordance with this invention, the local interface 13. Also shown for completeness in Fig. 1 is a wireless connection between the MS 10 and a base station (BS) 14A of a wireless (cellular) network 14, such as a CDMA network Note that the MS 10 may include a camera 16 that is suitable for generating image data, such as photographs and/or video clips.

The memory of the MS 10 also stores a computer program for implementing this invention, as will be described below in relation to Figs. 2 and 3. It is a feature of this invention that the software of the CD 12 need not be modified to work with the MS 10 that operates in accordance with this invention.

This invention is disclosed below in the context of a dial-up mode for the MS 10 that can be referred to as a "Terminating Dial-up Mode". As the name indicates, this mode provides a capability to the MS 10 to locally terminate (form one end of) a dial-up connection from the CD 12, rather than to bypass or merely relay such a connection to a wireless bearer, such as the cellular network 14 shown in Fig. 1. An extension to the AT command set is presently preferred for this purpose, although the invention is not limited to only the use of the AT command set.

In a CDMA wireless network 14 the extension can be provided in an AT command "+CRM" (set R_m interface protocol). The +CRM command is specified in TIA/EIA-IS707.3, and the command syntax is: AT+CRM=<Val>. As currently specified <Val> can have a value in the range of 0 to 4 for configuring the MS 10 into one of the following modes using the +CRM command.

<Val>	Mode
0	Asynchronous Data or Fax
1	Packet data service, Relay Layer R_m interface
2	Packet data service, Network Layer R_m interface, PPP
3	Packet data service, Network Layer R_m interface, SLIP
4	STU-III Service

In the presently preferred embodiment of this invention the new, extended command AT+CRM=5 is interpreted by the MS 10 as a command to place the MS 10 into the "Terminating Dial-up Mode" of operation. The invention enables an end user to configure the MS 10 for terminating connections, and to subsequently connect to the MS 10 from the CD 12 by dialing the AT+CRM=5 command from conventional dialer software 12D. During this process the CD 12 functions in a conventional manner as though it were connected to a modem, while the MS 10 effectively functions as a combination of both a modem and an end device. No new drivers or other software are required by the CD 12 to operate with a MS 10 in the "Terminating Dial-up Mode" of operation, and all components of the CD 12 may remain unchanged from those found in a conventional CD 12.

The modem software 10D of the MS 10 is preferably modified to correctly interpret the extended AT+CRM=5 command, i.e., the "Terminating Dial-up Mode" command, so as to configure the resident IP protocol stack 10B to route received packets to local applications, such as to the peer application 10A.

The operation of terminating the connection at the MS 10 can be performed in one of at least two modes. A first approach is via a CD 12 initiated connection, as depicted in Fig. 2, while a second approach is via a MS 10 initiated connection, as depicted in Fig. 3. It is assumed that the commands and messages depicted in Figs. 2 and 3 flow over the local interface 13 between the IR/USB/Bluetooth™ interfaces 10C, 12C of Fig. 1.

In Fig. 2 the CD 12 at Step A sends the new, extended AT command AT+CRM=5 to the MS 10 through the dialer software 12D and via the local interface 13. This is an indication to the MS 10 that the CD 12 desires to establish a terminating connection. At

Step B it is assumed that the MS 10 responds back to the CD 12 with an OK. At Step C the CD 12 sends a conventional ATD #777 sequence to establish a call, and a Step D the MS 10 responds back with a CONNECT indication. At Step E any necessary PPP negotiations occur between the MS 10 and the CD 12, and at Step F the IP connection is established. During the Step E and F processes the MS 10 assigns some arbitrary IP address, for example10.0.0.1, to the CD 12 and some other arbitrary IP address, for example 10.0.0.2, to itself. The MS 10 also configures its resident IP protocol stack to route incoming IP packets to the local application(s), such as the peer application 10A. Also, the dialer software 12D of the CD 12 adds an IP interface to the OS of the CD 12. This is similar to normal dial-up connections where dialer software adds a PPP interface to the operating system of the CD after a successful authentication from an ISP (Internet Service provider). Communication subsequently occurs between the peer applications 10A, 12A using the local, short range IR/USB/Bluetooth™ interface 10C, 12C.

In the second mode referred to above the MS 10 is enabled to initiate the dial-up connection, for example to synchronize data with the CD 12 based on user preferences, such as every morning, or whenever the MS 10 connects the CD 12. Referring to Fig. 3, at Step A the CD 12 sets the MS 10 into an auto-answer mode by sending an ATS0=1 command sequence to the MS 10, to which the MS 10 responds with an OK (Step B). At some point the MS 10 receives a trigger signal, such as one from the peer application 10A resident on the MS 10, to establish an IP connection with the CD 12. In response to receiving the trigger signal, at Step C the MS 10 sends a RING to the CD 12. The CD 12 sets up the physical layer connection and at Step D a CONNECT string is sent after the physical layer is set up. At Step E the PPP negotiations occur, as was described in regard to Step E of Fig. 2, with arbitrary IP addresses being assigned. The dialer software 12D adds the PPP as an IP interface to the OS of the CD 12, as was discussed above with regard to Fig. 2, and at Step F the peer applications 10A, 12A communicate via the established IP connection.

The operation performed by the CD 12 at Step A of Fig. 3 may be considered to essentially emulate a conventional operation where the CD 12 sets the MS 10 to the auto-answer mode when a call from an application is expected. When the call from the cellular network 14 arrives the MS 10 is then enabled to automatically answer the call, and send

the RING to the CD 12. In this case the CD 12 is using the MS 10 as a modem for communicating with some remote application via the cellular network 12.

In accordance with this invention, however, the CD 12 actually initiates the connection, which in a conventional setup would be initiated by the cellular network 14. The peer application 12A communicates directly with the local peer application 10A of the MS 10 using the IP protocol 12B, 10B, and the cellular network 14 need not be involved at all.

Note that this invention is preferably software based, and no hardware changes need be made to either the MS 10 or the CD 12.

Because the cellular network 14 is not required for communications between the peer applications 10A, 12A, a savings in cellular air time usage is achieved, as is an increase in speed as the IP connectivity is available over a short-haul, lower latency interface, such as the IR/USB/Bluetooth™ interface 12C. Furthermore, standard IP-based connectivity between the CD 12 and the MS 10 can be achieved, which implies that an application written for a first MS 10 can be readily ported to a second MS 10, so long as the second MS 10 provides IP connectivity.

As can be appreciated, the use of this invention aids in migrating peer-to-peer applications to IP-based protocols. Exemplary and non-limiting applications include PIM and Synchronization. Prior to this invention, these applications were based on proprietary message exchange between the MS 10 and a vendor-specific application installed on the CD 12.

The foregoing description has provided by way of exemplary and non-limiting examples a full and informative description of the best method and apparatus presently contemplated by the inventors for carrying out the invention. However, various modifications and adaptations may become apparent to those skilled in the relevant arts in view of the foregoing description, when read in conjunction with the accompanying drawings and the appended claims.

As one example, similar extension can be defined for GSM/GPRS devices. Also, this invention is not limited to the use of only the value of 5 for the AT+CRM command, or to only the use of the AT+CRM command, as other values and/or types of commands might be defined to be used to place the MS 10 into the "Terminating Dial-up Mode" of operation.

Also, it should be noted that the peer-to-peer applications that can be accommodated by the use of this invention are not limited to only the above-mentioned PIM (Personal Information Management) and Synchronization applications. As non-limiting examples, other peer-to-peer applications can include, but are not limited to: File Synchronization and Backup applications, such as those that can be used for photos and video clips made by the camera 16 of the MS 10; applications that would download to the MS 10 one or more music clips that the user wishes to listen to when mobile; Parameter Provisioning applications such as those for provisioning user preferences, such as a Date/Time/Calendar format through a P2P application residing on the MS 10 and CD 12 (currently this is accomplished by using the UI (User Interface) of the MS 10); and debugging applications for debugging the MS 10 over the terminating connection. In this latter example, since IP connectivity is available between the MS 10 and the CD 12, debugger software can be run on the CD 12 which connects to a debugging agent running on the MS 10, and that can control execution of instructions on the MS 10. The debugger software can also show desired information related to the MS 10, such as the value of variables currently residing in the memory and execution stack of the MS 10.

However, all such and similar modifications of the teachings of this invention will still fall within the scope of this invention.

Furthermore, some of the features of the present invention could be used to advantage without the corresponding use of other features. For example, only the process of Fig. 2 might be implemented in a given application setting, and not the process of Fig. 3, and vice versa. As such, the foregoing description should be considered as merely illustrative of the principles of the present invention, and not in limitation thereof.